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(56) Documents cited
GB 2163296 A GB 1199767 A GB 1074898 A
GB 1047220 A US 3887920 A

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# (54) Microwave absorber

(57) A microwave absorber 10 is provided comprising a sheet 12 of electromagnetically lossy material arranged on a metal surface 14. The sheet 12 incorporates within it a two dimensional array of dipoles 16 at a constant distance from the sheet surface 18. In the absence of the array of dipoles 16, the sheet 12 acts as a conventional tuned microwave absorber. The array of dipoles 16 is arranged to produce resonant reflection at a higher frequency than that of the conventional absorber equivalent to the sheet 12. The combination absorber 10 accordingly simulates two absorbers tuned to different frequencies, but with the thickness of only the lower frequency absorber.

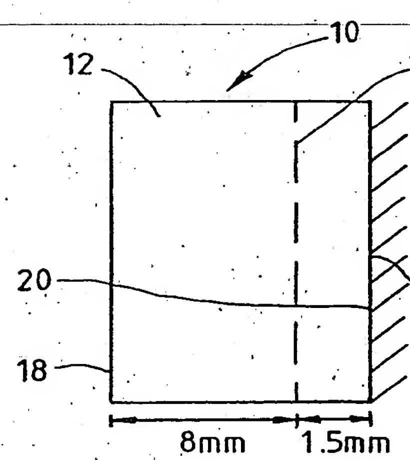


Fig. 1.

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

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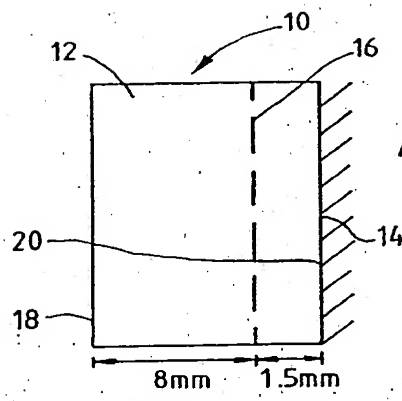


Fig. 1.

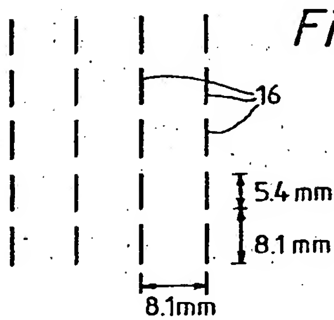


Fig. 2.

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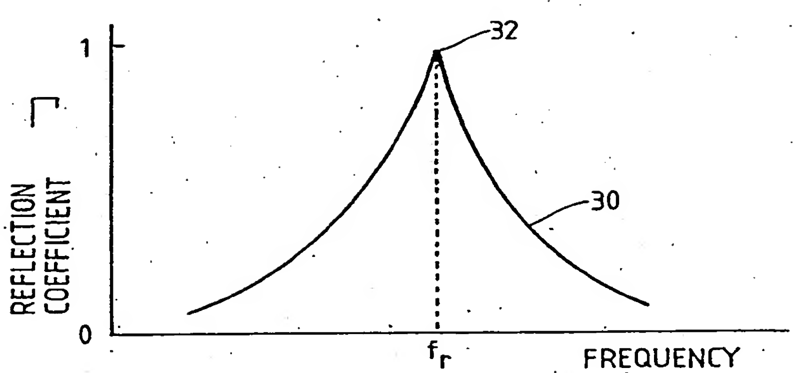
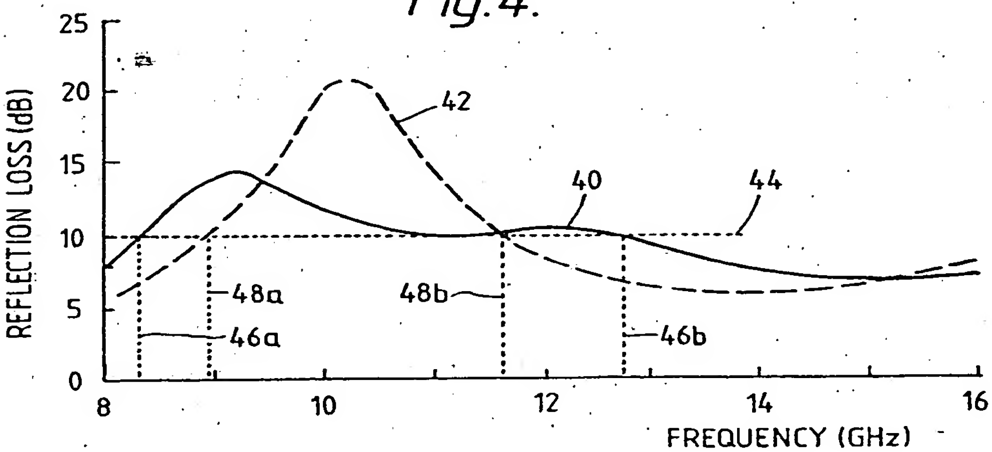
Fig.3.



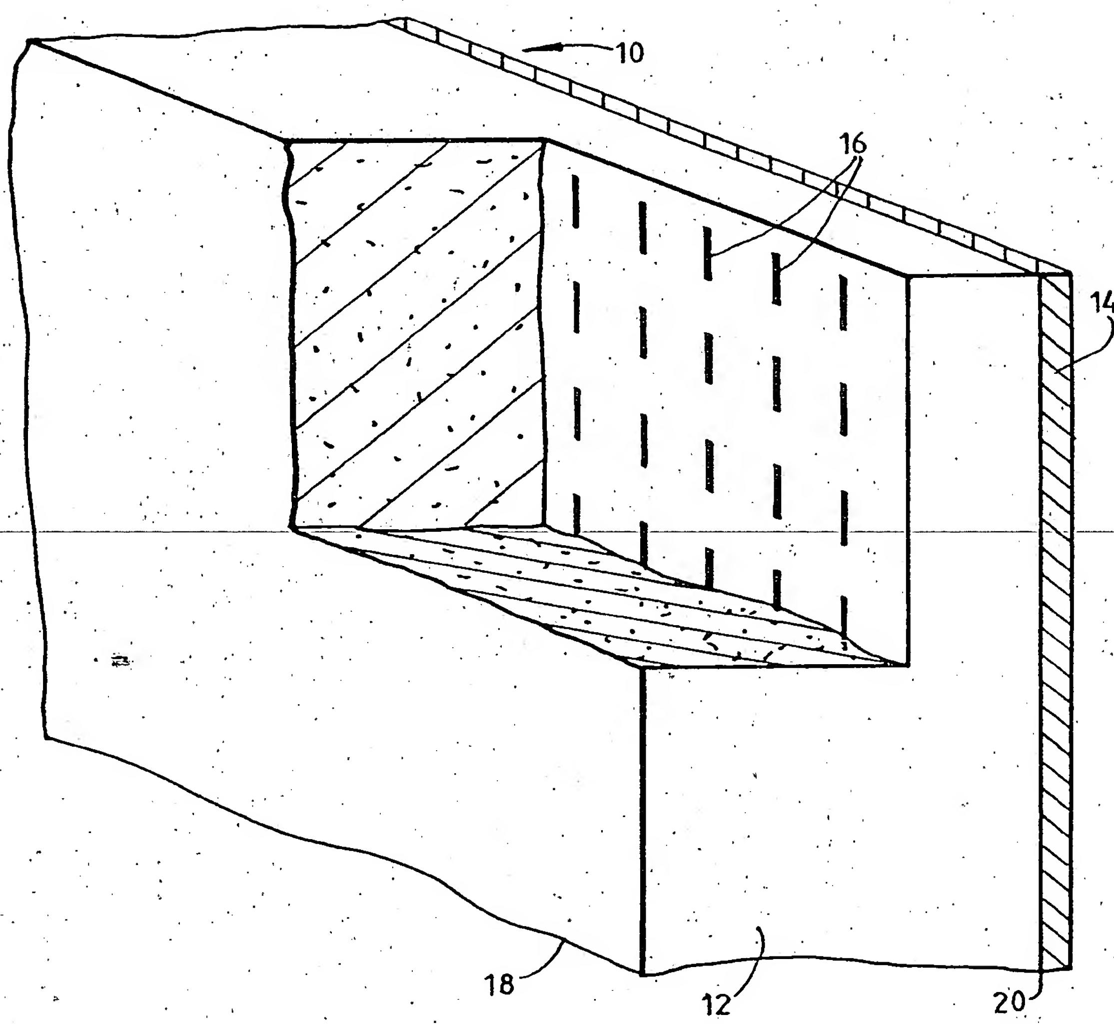
1
0
REFLECTION COEFFICIENT
Γ
32
30
$f_r$
FREQUENCY


Fig.4.



25
20
15
10
5
0
REFLECTION LOSS (dB)
42
40
44
48a
48b
46a
46b
8
10
12
14
16
FREQUENCY (GHz)

Fig.5.



MICROWAVE ABSORBER

This invention relates to a microwave abosrber of the kind used to reduce reflection of microwave power from metal surfaces.

Conventional microwave absorbers can be divided into two basic types, broad band and narrow band devices. The broad band type operates over a wide frequency range but is undesirably bulky. The narrow band or resonant type consists of a single thin layer of electromagnetically lossy or absorbing material with an electrically conducting backing. An electromagnetic wave incident on the front surface of the layer is partially reflected and partially transmitted to the backing for reflection once more. The back-reflected wave passes through the absorbing material and is recombined with the front-reflected wave. These two will be in antiphase and therefore cancel at a particular frequency dependent on the thickness and electromagnetic parameters on the absorbing material. In practice, the thickness of the absorbing layer is adjusted or tuned to produce cancellation at a desired frequency. The thickness is approximately one quarter of the wavelength in the absorbing material, hence the commonly used term "quarter-wave absorber". This is not, however, an exact relationship, since the actual thickness required in practice depends on the relative preponderance of magnetic or dielectric loss. Such losses are essential to absorb the incident energy.

The quarter wave absorber has the disadvantage that it produces significant reflection only over a narrow band of frequencies. The reflection can be high in this band, in excess of 20dB; for many purposes, however, the requirement is for reflection over a wider band, and only a moderate degree of reflection is required. To extend the bandwidth of reflection, it is possible to employ a multilayer arrangement of quarter wave absorbers. This, however, merely reintroduces the size and weight penalties of coventional broad band absorbers.

It is an object of the invention to provide an alternative form of microwave absorber.

The present invention provides a microwave absorber including:-

1 a sheet of electromagnetically absorbing material arranged to produce reflection cancellation; and

2 a two dimensional array of electrically conducting elements arranged within the sheet at a constant distance from its surface to broaden reflection loss bandwidth.

The invention provides the advantage that it produces antireflection properties similar to two narrow band absorbers in series while having the thickness of only the lower frequency of the two.

The invention may include two or more two dimensional arrays of discrete electrically conducting elements each arranged at a respective constant distance from the sheet outer surface and producing maximum reflection at a respective frequency higher than the first. This produces an effect similar to multiple narrow band absorbers in series, but with the thickness of only the lowest frequency device.

The electrically conducting elements may be in the form of individual antenna-like devices resonant at the second frequency to be reflected. Each may be a dipole or a pair of crossed dipoles.

In order that the invention might be more fully understood, an embodiment thereof will now be described, with reference to the accompanying drawings, in which:-

Figure 1 is a schematic view of a microwave absorber of the invention;

Figure 2 illustrates an array of dipoles incorporated in the absorber of Figure 1;

Figure 3 is a graph of reflection coefficient against frequency for the dipole array of Figure 2 when located in a continuous medium;

Figure 4 shows graph of reflection loss against frequency for an absorber of the prior art compared with the like for the invention; and

Figure 5 is a sectioned three dimensional view of the absorber of Figures 1 and 2.

Referring to Figure 1, there is schematically shown a sectional view of a microwave absorber 10 of the invention. The abosrber 10 consists of a sheet 12 of material which is electromagnetically lossy at microwave frequencies. The sheet 12 is 9.5mm thick, with a permeability of (1.04 - j0.255) and a permitty of (4.7 - j0.185) at 12.5 GHz. The material is manufactured by Emerson and Cuming, an American company, and designated MF112. The sheet 12 is laid over a metal surface 14 from which it is required to reduce reflection. A two dimensional array of dipoles 16 is arranged within the sheet 12 parallel to the latter's surfaces 18 and 20 at distances 8mm and 1.5mm respectively.

Referring now also to Figure 2, the array of dipoles 16 is shown in plan. The dipoles are each 5.4mm long with 8.1mm spacing between adjacent dipole centres in both vertical and horizontal directions.

The microwave absorber 10 operates as follows. In the absence of the array of dipoles 16, the sheet 12 would constitute a resonant absorber for a frequency of 10.2GHz. The array of dipoles 16 if located in a continuous medium would reflect in accordance with the Figure 3 graph 30 of reflection coefficient $\Gamma$ against frequency. The graph 30 has a single peak 32 at a resonant frequency $f_r$ and falls either side. At $f_r$, the array of dipoles 16 simulated a continuous conducting layer, but is transparent to radiation having a frequency far from $f_r$. The microwave absorber 10 accordingly incorporates a true metal reflecting surface 14 together with a simulated reflector for frequencies near $f_r$. With the dipole array dimensions previously quoted, and with the array located in a continous medium having the electromagnetic characteristics of the material MF112, $f_r$ is 12.5GHz.

Referring now to Figure 4, there are shown graphs 40 (solid line) and 42 (chain line) of reflection loss against frequency for the sheet 12 and metal reflector 14 with and without the array of dipoles 16. Graph 42 accordingly corresponds to a prior art resonant absorber. A horizontal dotted line 44 indicates a reflection loss of 10dB. Vertical dotted lines 46a/46b and 48a/48b indicate where graphs 40 and 42 cross the line 44. Graph 42 is above 10dB in the interval 8.95 to 11.6GHz approximately, and the corresponding interval for graph 40 is 8.3 to 12.7GHz. The 10dB level reflection loss bandwidth is accordingly increased from 2.65 to 4.4GHz, or over 65%.

It will be appreciated from electromagnetic theory that the array of dipoles 16 will have reflection properties which are sensitive to the polarization of the incident wave. The foregoing description assumed that the incident electric vector was parallel to the length of each dipole. To avoid polarization sensitivity, crossed dipoles may be employed. Moreover, other antenna-like devices may be used provided they are arranged as a reflecting array of discrete electrically conducting elements.

To extend the reflection loss bandwidth further, the sheet 12 of Figure 1 may incorporate a plurality of arrays of electrically conducting elements such as 16. The arrays would be located at respective distances from the sheet surface 18 and be arranged for reflection at respective resonant frequencies.

Referring now to Figure 5, in which parts previously mentioned are like referenced, there is shown a three dimensional view of the absorber 10 described with reference to Figures 1 and 2. The absorber 10 is shown with a section of the lossy sheet 12 removed to expose the dipole array 16. The material of the sheet 12 is indicated where internally exposed by a dot pattern.

CLAIMS

1. A microwave absorber including:-

(1) a sheet of electromagnetically absorbing material arranged to produce reflection cancellation; and

(2) a two dimensional array of electrically conducting elements arranged within the sheet at a constant distance from its surface to broaden reflection loss bandwidth.

2. A microwave absorber according to Claim 1 including at least one additional two dimensional array of electrically conducting elements within the sheet at a constant distance from its surface.

3. A microwave absorber according to Claims 1 or 2 wherein the electrically conducting elements are insensitive as regards reflection to the polarization of incident electromagnetic radiation.

4. A microwave absorber according to Claim 3 wherein the electrically conducting elements are crossed dipoles.

Amendments to the claims have been filed as follows

1. A microwave absorber including:-

   (1) a sheet of electromagnetically absorbing material of thickness appropriate to produce reflection cancellation at a first frequency, and

   (2) a two dimensional array of electrically conducting elements located within the sheet at a substantially constant distance from its surface, the array being arranged to produce resonant reflection at a second frequency higher than the first frequency such that the absorber simulates at least two narrow band absorbers.

2. A microwave absorber according to Claim 1 including at least one additional two dimensional array of electrically conducting elements within the sheet at a constant distance from its surface.

3. A microwave absorber according to Claims 1 or 2 wherein the electrically conducting elements are insensitive as regards reflection to the polarization of incident electromagnetic radiation.

4. A microwave absorber according to Claim 3 wherein the electrically conducting elements are crossed dipoles.

5. A microwave absorber substantially as herein described with reference to the accompanying drawings.

PATENTS ACT 1977
EXAMINER'S REPORT TO THE COMPTROLLER
UNDER SECTION 17(5)
(The Search Report)

-8-

Application No.
8525394

FIELD OF SEARCH: The search has been conducted through the relevant published UK patent specifications and applications, and applications published under the European Patent Convention and the Patent Co-operation Treaty (and such other documents as may be mentioned below) in the following subject-matter areas:-

UK Classification H1Q

(Collections other than UK, EP & PCT:) Selected US specifications in IPC subclass H01Q

DOCUMENTS IDENTIFIED BY THE EXAMINER (NB In accordance with Section 17(5), the list of documents below may include only those considered by the examiner to be the most relevant of those lying within the field (and extent) of search)

| Category | Identity of document and relevant passages | Relevant to claim(s) |
|---|---|---|
| X,E | GB-A-2163296 (Elliot Bros) | 1 |
| X | GB-1199767 (Eltro) (cf figures 5 to 8) | 1 |
| X | GB1074398 (Eltro) (cf figure 10) | 1 |
| X | GB-1047220 (Eltro) | 1 |
| X | US-3887920 (Wright) | 1 |

CATEGORY OF CITED DOCUMENTS

X relevant if taken alone
Y relevant if combined with another cited document
P document published on or after the declared priority date but before the filing date of the present application
E patent document published on or after, but with priority date

Search examiner
T BERRY
Date of search
11 April 1986

SF 2